EXPERIMENTAL INVESTIGATION ON FOUR STROKE SI ENGINE USING PETROL AND BIOGAS BLENDS AS AN ALTERNATE FUEL

YOGESH JADHAV, VINAYAK NARWADE, AWES ANSARI, SURAJ MASKE & SANKET THAKARE

Department of Mechanical Engineering, College of Engineering, Pune, Maharashtra, India

ABSTRACT

The world's rapidly depleting petroleum supplies, their ever increasing costs and the constantly increasing pollution from fossil petroleum fuels have led to an comprehensive search for alternate fuels. Vegetable oils or Biogas owing to their reproducibility, can be considered as alternate option for fossil fuels. In this experimental investigation, Biogas which is considered a potential alternate fuel, is blended in different proportions with petrol, and its efficiency at various load and rpm was analyzed and used as a fuel in a Spark Ignition engine. Performance, combustion and emission characteristics at various loads are calculated using a multi cylinder Spark Ignition engine and compared with neat Petrol. The lessons learned from the experimental investigation will be discussed including comparisons between Brake thermal efficiency, Brake Power and Emissions. The main advantage of Biogas is that it can be produced from readily available materials like cow dung and municipal waste.

KEYWORDS: Four Stroke Spark Ignition Engine, Biogas, Petrol, Renewable Energy Resources, Alternate Fuels, Performance and Emission Characteristics, Blended Fuel

ABBREVIATIONS

Table 1

Sn	Abbreviation	Full Form
1	IC	Internal Combustion
2	SI	Spark Ignition
4	HC	Hydrocarbon
5	CO	Carbon Monoxide
6	BSFC	Brake Specific Fuel Consumption
7	BP	Brake Power
8	CV	Calorific Value
9	G10	Blend of 10% Biogas and 90% Petrol
10	G20	Blend of 20% Biogas and 80% Petrol
11	G40	Blend of 40% Biogas and 60% Petrol

INTRODUCTION

Biogas is useful as a substitute for firewood, coal, petrol and diesel. Biogas systems also provide a residue of organic waste, which after anaerobic decompositionthat can be used as fertiliser.

Energy is essential for human existence. We know that energy is obtained from numerous sources, it is firewood, coaland fossil fuels which have been voraciouslyused for many useful purposes. This century has been the witness of tremendous growth of numerous industries which are entirely dependent on energy sources. Fossil fuels, in particular have the most eminent role in the growth of industry and agriculture.The energy crisis has made it compulsary to search

alternate sources of energy. It is impossible to replace fossil fuels entirely. On the other hand, dependence on fossil fuels would have to be controlled so as to make it available for our posterities and in pivotal sectors till some tantamount alternate energy sources, preferably renewable are made available. Though the calorific value of Biogas is not high as it's contemporaries, it could meet some local needs. Following table would provide an idea of thermal efficiency and calorific values of different fuels used in day-to-day life.

Table 2

Calorific Value and Thermal Efficiency of Different Fuels		
Fuels	**Calorific Values in Kilo-Calories**	**Thermal Efficiency in %**
Biogas	$4713/m^3$	60
Dung cake	2010/kg	11
Firewood	10300/kg	17
Diesel	10579/kg	33
Kerosene	10850/kg	60
Petrol	11169/kg	50

These values signify that biogas can perform similarly to fossil fuels with increased thermal efficiency with regards to the content of methane. The biogascan also be used in IC engines for which there is scope for further research and development. Biogas, thus can be used as an alternate energy resource for the fossil fuels. A typical composition of biogas produced from the biogas plant is as follows:

Table 3

Components	Percentage
Methane	60.0%
Carbon Dioxide	38.0%
Nitrogen	0.8%
Hydrogen	0.7%
Carbon Monoxide	0.2%
Oxygen	0.1%
Hydrogen Sulphide	0.2%

EXPERIMENTAL INVESTIGATION

Experimental Setup

A multi-cylinder, water cooled, four stroke Spark Ignition engine generating 50 kW power at 6200 rpm was used for this investigation. Fuels used were Petrol and blends of Biogas-Petrol. Exhaust gas characteristics were measured using an exhaust gas analyzer. CO and HC proportion was shown by the exhaust gas analyzer. Exhaust gas temperature (EGT) was determined by using RTD probe.

Schematic Diagram

The diagram shows the experimental setup consisting of a WagonR engine and its components. It consists of Eddy current Dynamometer which is connected to the engine on its front side. The engine is connected to a digital panel which displays different readings on it. The exhaust outlet is at the rear side of the engine. At the exhaust outlet of the engine a gas analyzer is connected to it to measure the exhaust readings of CO and HC. The fuel tank is located on the right side of engine.
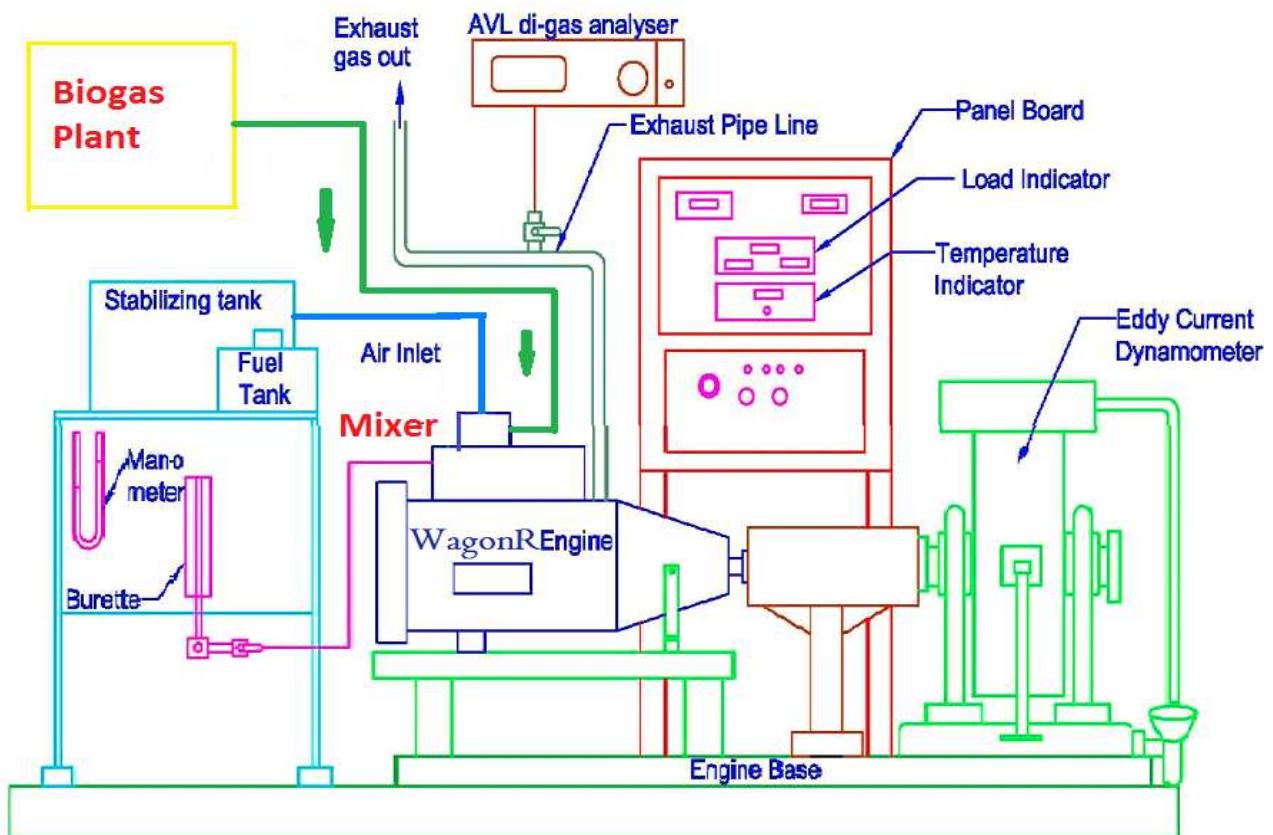
Figure 1

Engine Specification

Table 4

Sn	Specifications	Value
1	Bore diameter	69 mm
2	Stroke Length	72 mm
3	Rated Power	50 kW @ 6200 rpm
4	Compression Ratio	10
5	No. of cylinders	4
6	Cooling System	Water cooled

EXPERIMENTAL PROCEDURE

The experiment was carried out on a WagonR engine. At the start of the experiment petrol was loaded in the fuel tank. The engine was started by a cell start on the digital panel. After the starting of engine, the engine was allowed to become stable and readings were noted. The engine was first kept at constant speed of 1500 rpm and the torque was varied on the digital panel. The exhaust gas temperature readings where noted down from the panel. The exhaust emission readings of CO and HC were noted down from the exhaust gas analyzer located on the exhaust pipe. The time was recorded for 10cc consumption of fuel through it. After this the torque was increased and the engine was allowed to become stable and the readings were noted. The torque was increased from 0 to 20 with a interval of 5 and readings noted for each.

After the petrol test was over blending tests were to be conducted. For this the blend mixture with 10% Biogas and 90% petrol was prepared. Before putting this mixture in the engine, the remaining petrol in the fuel tank was removed

and the engine was kept running till it consumes whole petrol that was present in it. This was done each time when the blend mixture was changed in the tank so as to avoid mixing of the mixtures and to get accurate readings. Now the blend mixture was supplied and readings were noted. Further for blend mixtures of 20% and 40% the readings were noted down. After this the speed of the engine was increased to 1900 rpm and to 2100rpm and the similar procedure was carried out.

CALCULATIONS

Calculation for CV of Blended Fuel

For G10 BLEND:

CV of G10 = 0.10*CV per litre of Biogas + 0.90* CV per litre of neat Petrol

= 0.10*30000 + 0.90*44000

= 42600 kJ/kg

Similarly for all blends CV is calculated and is given in following table,

Table 5

SN	BLEND	CV (kJ/kg)
1	G10	42600
2	G20	41200
3	G40	38400

Calculation for Brake thermal Efficiency and BSFC:

- For Brake power (BP)

$$BP = \frac{2*\pi*N*T}{60*1000} \text{ kW}$$

Where,

N = Revolutions per minute

T= Torque

For 10Nm torque, BP is

$$BP = \frac{2*\pi*1900*10}{60*1000} \text{ kW} = 1.989 \text{ kW}$$

Thus the BP is calculated and is summarized in following table,

Table 6

SN	Torque(Nm)	BP (kW) 1900rpm	BP (kW) 2100rpm	BP (kW) 2300rpm	BP (kW) 2500rpm
1	10	1.99	2.20	2.41	2.62
2	15	2.98	3.30	3.61	3.93
3	20	3.98	4.39	4.82	5.23

- b) For Brake Thermal Efficiency

$$\text{Efficiency} = \frac{BP*3600*100}{mf*CV}$$

Where,

mf = Total Fuel consumed per hour

B.P = Brake Power

CV = Combined Calorific value of Petrol and Biogas

- c) For Brake specific fuel consumption (BSFC)

$$\text{BSFC} = \frac{Total\ Fuel\ Consumption}{BP}$$

Where,

Total fuel consumption = Biogas + Petrol consumed

B.P = Brake Power

In this way all efficiencies are calculated at the various values of torques.

## GRAPHICAL ANALYSIS

### Graphs of Testing at Constant RPM

A) 1900 rpm
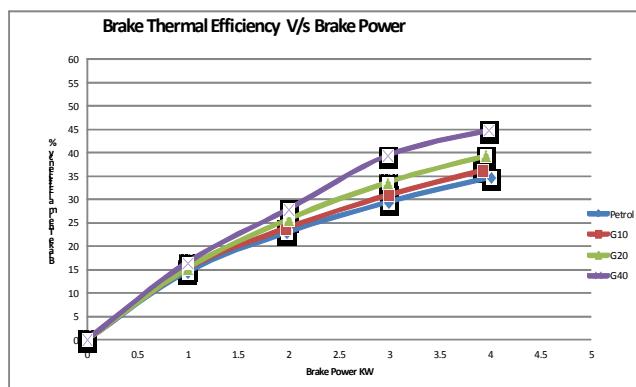
Figure 2
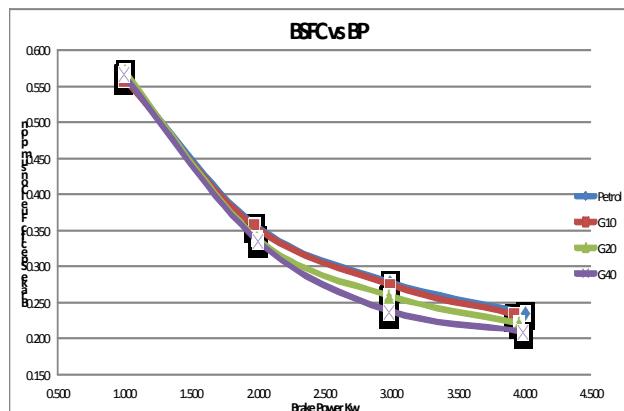
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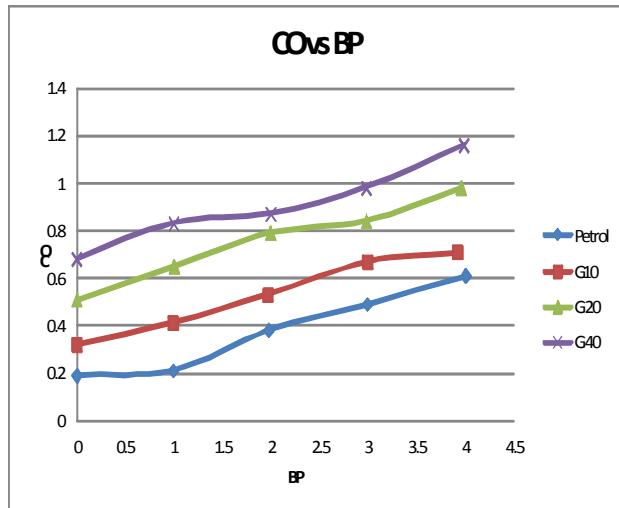
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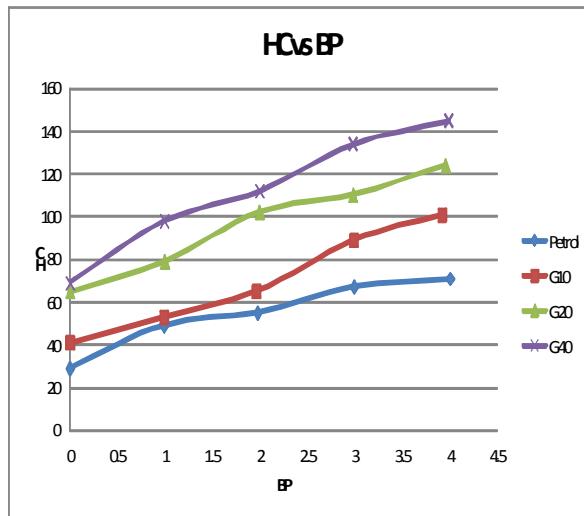
Figure 5

B) 2100 rpm :
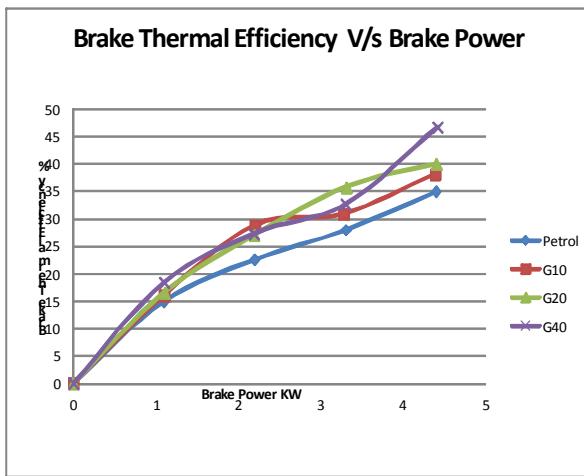
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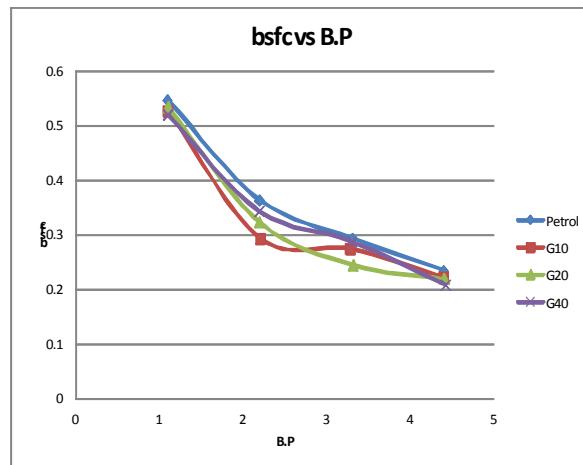
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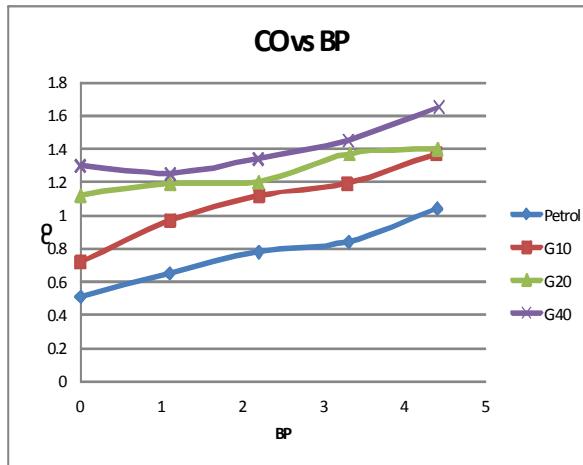
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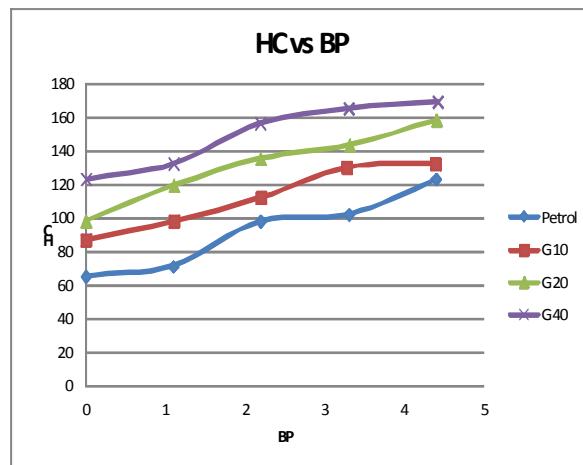
Figure 9

Graphs of Testing at Constant Load:

   A) 15 Nm
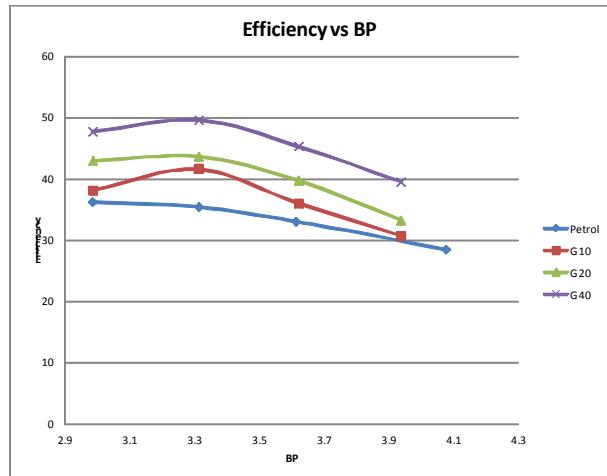
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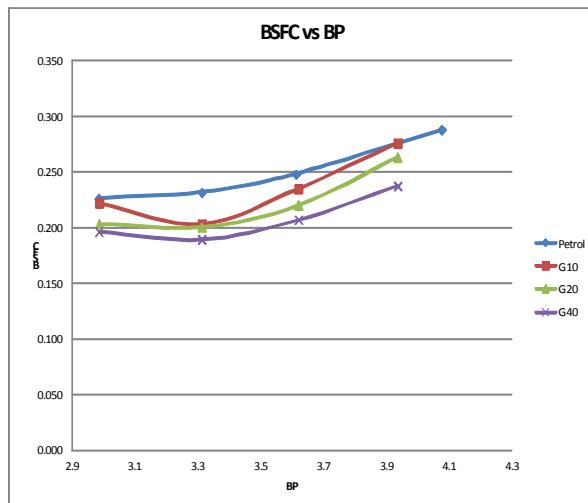
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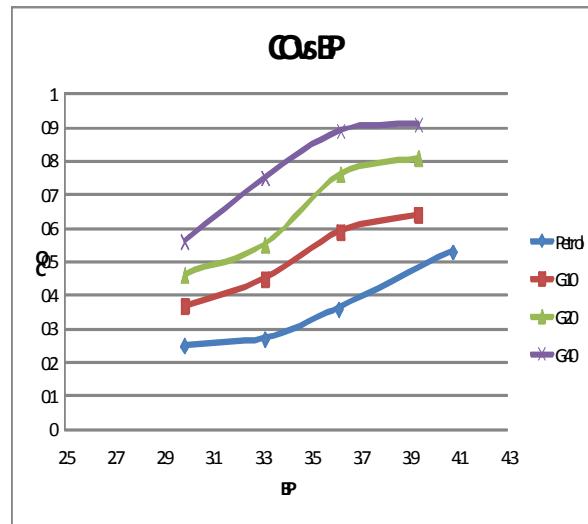
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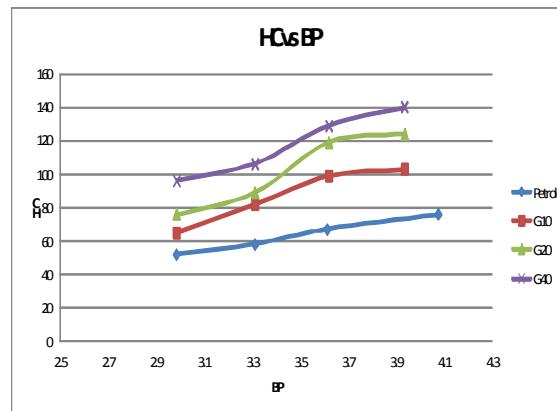
Figure 13

B) 20 Nm :
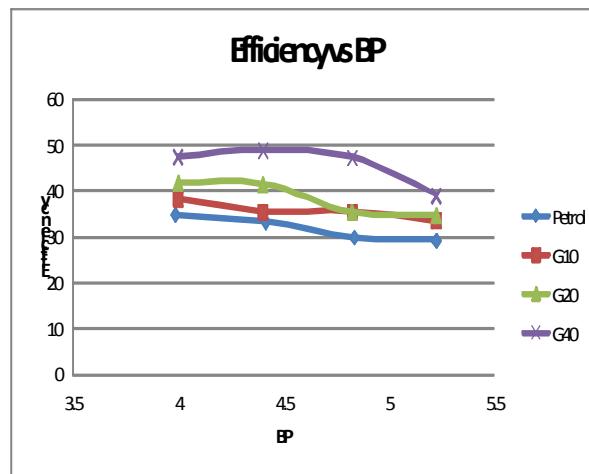
Figure 14

Figure 15

CO vs BP

Figure 16

HC vs BP
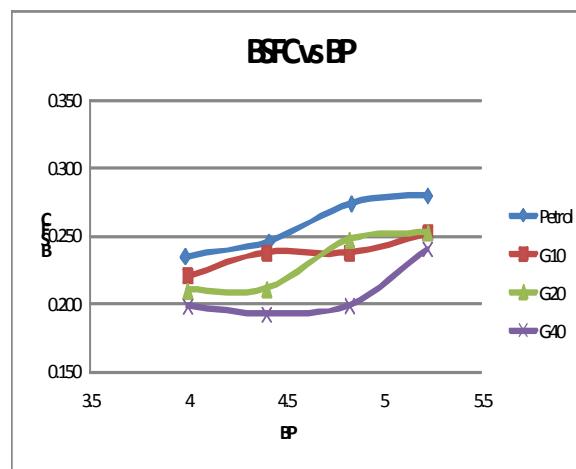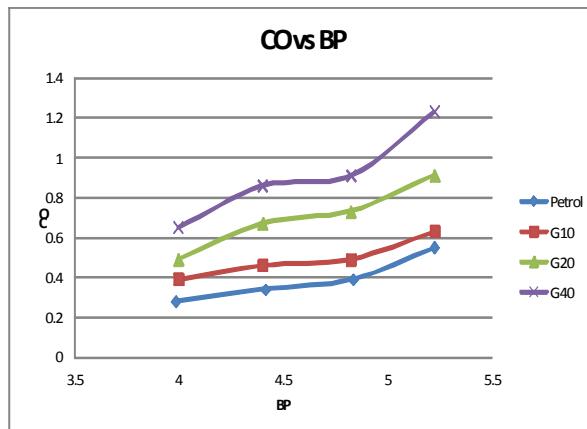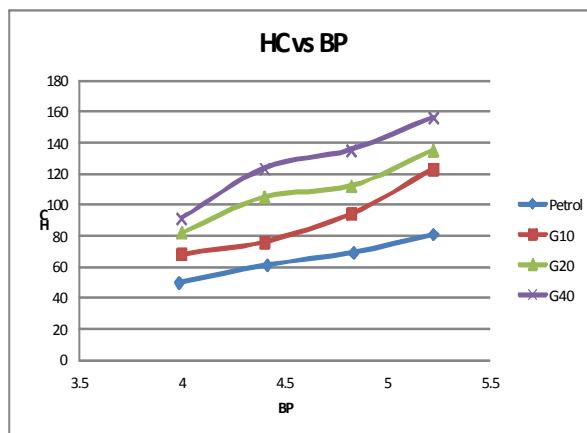
**Figure 17**

RESULTS FROM GRAPHS

- Engine was successfully operated with blends of Biogas with petrol upto 40% blending and 2500 rpm.

- In comparison of petrol fuelled engine, Biogas blended with petrol is more efficient.

- Higher the content of Biogas in petrol higher is the efficiency.

- When the blends of Biogas were increased with 10%, 20% and 40% it was observed that Break Specific Fuel Consumption decreases in proportion to the increase in blends.

- The amount of CO and HC in the exhaust gases was increased due to the Biogas composition.

CONCLUSIONS

In our experimental investigation, four Cylinder Spark Ignition engine was operated successfully using Biogas and Petrol blends at room temperature.

- Both the fuels, Biogas and Petrol, were used without any change in their chemical composition.

- Petrol and Biogas blends can be used in SI engine without any modification in engine.

- Brake thermal efficiency increases as the proportion Biogas is increased in blend.

- Emission level for CO and HC increased with increase in Biogas proportion.

- Exhaust gas temperature was found to be increased with increase in Blends.

- Brake Specific Fuel Consumption Decreases with the increase in the Biogas Blends.

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